BOOK REVIEW

FOUNDATION ANALYSIS USING SIMPLE PHYSICAL MODELS, by John P. Wolf. Prentice-Hall, Englewood Cliffs, NJ 07632, 1994. No. of pages: 423. Price: US $65. ISBN 0-13-010711-5.

This is the third book by John P. Wolf (an internationally recognized, prolific writer in theoretical foundation dynamics) dealing with soil–structure interaction under dynamic excitation. The two earlier books (published in 1985 and 1988) offered a comprehensive exposition of rigorous elastodynamic methods of analysis, in *frequency* and *time* domains. Now, the emphasis is on simplified methods of analysis. The author's aspiration is that such methods can be understood and, therefore, utilized by civil engineers, as the latter are familiar with the '*strength-of-materials*' simplifications of statics and mechanics. The systematic step-by-step derivation of all methods and applications in the book helps greatly in that direction. Nevertheless, it is felt that *some* knowledge of dynamics (more than just elementary) would be valuable, if not necessary, in fully comprehending the methods offered in the book.

Two main categories of models (of different nature and serving different objectives) are developed in the book. First and foremost, to obtain the dynamic stiffness and effective damping (material and radiation) of a foundation, the author develops '*cone*' models — one cone for each mode of vibration. The basic idea is quite familiar to geotechnical engineers who often compute approximately the distribution of vertical stresses under a foundation; they assume that the stressed region is confined between four (for rectangular foundation) or two (for strip foundation) planes, originating at the edges of the foundations and inclined outward at an angle of 60° (or nearly so). Within this region the stresses are a diminishing function of depth, only, as they are assumed to be uniformly distributed over the increasingly larger area of horizontal planes. For a circular foundation the stressed region is simply a truncated cone — hence the name of the method.

In addition to vertical stresses, displacements are *also* assumed to be uniform across each horizontal plane — in other words, '*plane sections remain plane*' after deformation, an approximation reminiscent of the basic '*strength-of-materials*' hypothesis. For rotational loading (rocking and torsion) the truncated cones respond as tapered beams in bending or torsion. The book develops and expands this idea to the fullest extent, covering all dynamic modes of surface and embedded foundations, supported not just by a homogeneous half-space but also by a soil stratum underlain by rigid or deformable rock.

A second type of models developed in the book are *lumped-parameter models*. They consist of a collection of a number (in some cases large) of springs, dashpots, and masses, all of which are characterized with frequency-independent parameters (constants). They are developed in such a way that the resulting force–displacement or moment–rotation relationship at the base of the foundation exhibits the frequency-dependent stiffness and damping characteristics of the actual foundation–soil system. Despite the fact that this collection of springs, dashpots, and masses can in some cases become awkward, their usefulness in practice will be especially appreciated by those who have often been frustrated while attempting to use presently available computer codes to study soil–structure interaction. Such codes do not routinely handle frequency-dependent 'springs' and 'dashpots', but would have no difficulty accomodating even a collection of such frequency-independent elements.

Following a fairly comprehensive introductory chapter in which the main ideas of the book are outlined and put into perspective, the next three chapters (the lengthier and most fundamental) refer to dynamic stiffnesses of foundations and are ordered according to the problem complexity — from the surface foundation on homogeneous half-space (Chapter 2) to foundations on a soil layer underlain by rigid or deformable rock (Chapter 3) and to embedded and pile foundations (Chapter 4).

Among the principal characteristics of these chapters are the step-by-step derivation of all results, the detailed *discussion* of the physical significance of the introduced approximations, and the numerous '*examples*'. The reader will no doubt find these '*discussions*' useful and insightful; their value goes far beyond the utility of the main models developed in the book. For example, in Chapter 2, the 15-page-long section 2.5, termed '*Why a cone model can represent the elastic half-space*', not only does it shed light into the nature of the cone models, but it also provides insight to the relationship between body (P and S) and Rayleigh wave propagation under a vertically vibrating footing (by clarifying the much misquoted

results of Miller and Pursey). Equally insightful is Section 2.8 called, appropriately enough, '*Insight on two-versus three-dimensional foundation modelling*', which among other things provides explanation of the causes of the 'paradoxical' increase in radiation damping (per unit foundation–soil contact area) with increasing footing elongation.

Having studied the homogeneous half-space in Chapter 2, the author expands in Chapter 3 the concept of the cone model to study a footing on a soil stratum. The new version of the model, called *unfolded layered cone* has an analogy in acoustics, formally recognized through the introduction of flexibility '*echo*' *constants*. The idea is fascinating and the model is shown to produce results in good accord with those of rigorous methods—quite an achievement for an analytical (even if not always very simple) method, which can work both in the time and frequency domains.

In Chapter 4 the ideas of a '*double cone*' and of '*mirror-image disks*' are developed and help in obtaining the dynamic stiffnesses and the impulse-response functions of a fully embedded foundation. The method has now become somewhat cumbersome, and lumped-parameter models come to help. To extend it to piles, the model borrows and integrates results from the literature on single piles and pile groups, while for arbitrarily shaped foundations, Chapter 5 derives Green's function for a vertical point load.

The last two chapters deal with the seismic response of a foundation (Chapter 6) or of a single structure supported on it (Chapter 7). Although some of the material in these chapters has appeared in Wolf's earlier books, its present inclusion is necessary for the book to stand on its own.

Of the four Appendices in the book, the first three present detailed mathematical derivations of Green's functions, lumped parameter models, and evaluation of convolution integrals. Appendix D develops the formulation for the dynamic stiffnesses on a multilayered soil, by using the concepts and results of Chapters 2 and 3. The material of this Appendix, lending itself readily to computer programming, could prove of much use in applying the ideas of the book in practice.

Overall, this is a well-written and artfully illustrated monograph which offers a wealth of ideas and tools to both a researcher and a practising engineer dealing with foundation dynamics. It will also be useful (and affordable, as it is very reasonably priced) to students of soil and structural dynamics.

GEORGE GAZETAS
Athens
Greece